Concentrations

$$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$$

Concentrations

$$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$$

$$M = \frac{\text{mol solute}}{\text{L soln}}$$

Concentrations

$$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$$

$$M = \frac{\text{mol solute}}{\text{L soln}}$$

$$m = \frac{\text{mol solute}}{\text{kg solvent}}$$

Concentrations

$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$

$120\,g\ Ca(NO_2)_2$ in $240\,mL$ soln $\rightarrow$ [ ]?

$M = \frac{\text{mol solute}}{\text{L soln}}$

$m = \frac{\text{mol solute}}{\text{kg solvent}}$

Concentrations

$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$

$M = \frac{\text{mol solute}}{\text{L soln}}$

$m = \frac{\text{mol solute}}{\text{kg solvent}}$

$120\,g\ Ca(NO_2)_2$ in $240\,mL$ soln $\rightarrow$ [ ]?

$120\,g\ Ca(NO_2)_2 \times \frac{1\,mol\ Ca(NO_3)_2}{132\,g\ Ca(NO_3)_2} = 0.91\,mol\ Ca(NO_2)_2$

Concentrations

$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$

$M = \frac{\text{mol solute}}{\text{L soln}}$

$m = \frac{\text{mol solute}}{\text{kg solvent}}$

$120\,g\ Ca(NO_2)_2$ in $240\,mL$ soln $\rightarrow$ [ ]?

$120\,g\ Ca(NO_2)_2 \times \frac{1\,mol\ Ca(NO_2)_2}{132\,g\ Ca(NO_2)_2} = 0.91\,mol\ Ca(NO_2)_2$

$\left(240\,mL \times \frac{1\,L}{1000\,mL}\right) = 3.8\,M\ Ca(NO_2)_2$

Concentrations

$$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$$

$$M = \frac{\text{mol solute}}{\text{L soln}}$$

$$m = \frac{\text{mol solute}}{\text{kg solvent}}$$

$98\ g\ NaOH$ in $2.2\ L\ H_2O$ $\rightarrow$ % ? m ?

Concentrations

$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$

$M = \frac{\text{mol solute}}{\text{L soln}}$

$m = \frac{\text{mol solute}}{\text{kg solvent}}$

98 g NaOH in 2.2 L H_2O → % ? m ?

$2.2\,L \times \frac{1000\,mL}{1\,L} \times \frac{1\,g}{1\,mL} = 2200\,g$

Concentrations

$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$

$M = \frac{\text{mol solute}}{\text{L soln}}$

$m = \frac{\text{mol solute}}{\text{kg solvent}}$

98 g NaOH in $2.2\text{ L } H_2O \rightarrow \%$? m ?

$2.2\text{ L} \times \frac{1000\text{ mL}}{1\text{ L}} \times \frac{1\text{ g}}{1\text{ mL}} = 2200\text{ g}$

$\frac{98\text{ g NaOH}}{(98\text{ g} + 2200\text{ g})} \times 100\% = 4.3\%$ NaOH

Concentrations

$\% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$

$M = \frac{\text{mol solute}}{\text{L soln}}$

$m = \frac{\text{mol solute}}{\text{kg solvent}}$

$98\text{ g NaOH in } 2.2\text{ L } H_2O \rightarrow \%\text{ , } m\text{ ?}$

$2.2\text{ L} \times \frac{1000\text{ mL}}{1\text{ L}} \times \frac{1\text{ g}}{1\text{ mL}} = 2200\text{ g}$

$\frac{98\text{ g NaOH}}{(98\text{ g} + 2200\text{ g})} \times 100\% = 4.3\%$ Na

$m \rightarrow 2200\text{ g} \times \frac{1\text{ kg}}{1000\text{ g}} = 2.2\text{ kg}$

$98\text{ g NaOH} \times \frac{1\text{ mol NaOH}}{40\text{ g NaOH}} = 2.45\text{ mol}$

$\frac{2.45\text{ mol NaOH}}{2.2\text{ kg}} = 1.1\text{ m}$ NaOH

Soln Stoichiometry

Soln Stoichiometry!

When 26.0mL of 2.54M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

Soln Stoichiometry!

When 26.0mL of 2.54M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

mass A → mol A → mol B → mass B

Soln Stoichiometry!

When 26.0mL of 2.54M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

Soln Stoichiometry!

When 26.0mL of 2.54M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

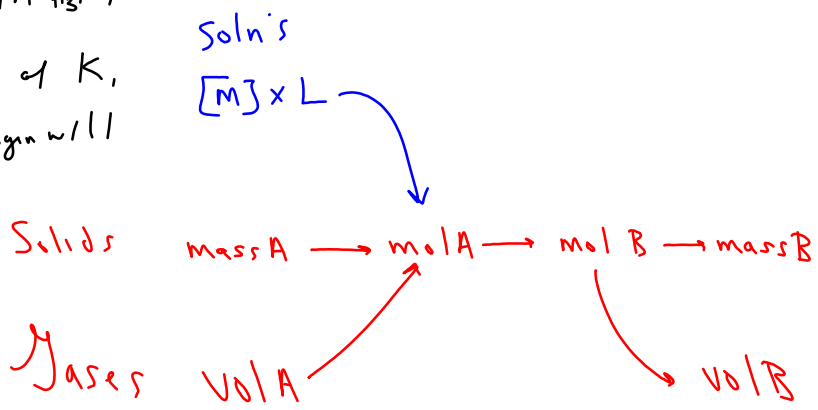
Soln's

Solids

Gases

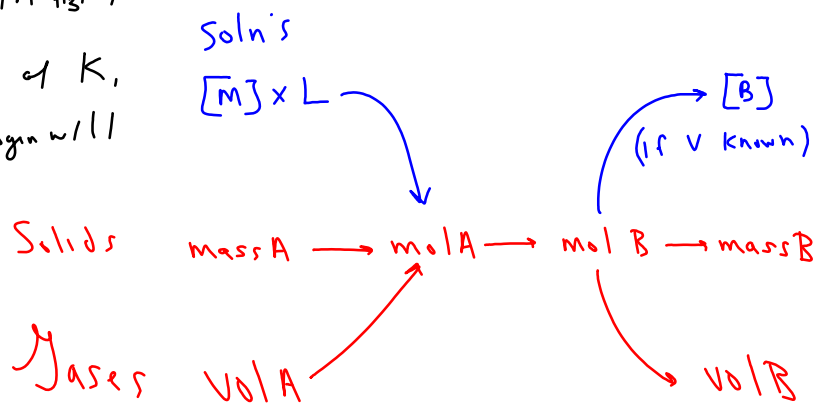
Soln Stoichiometry!

When 26.0mL of 2.54M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?



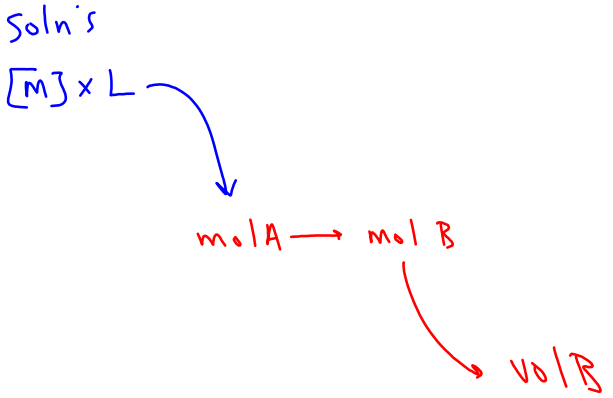
Soln Stoichiometry!

When 26.0mL of 2.54M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?



Soln Stoichiometry!

When 26.0mL of 2.54M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?



Soln Stoichiometry!

When 26.0 mL of 2.54 M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

$$2\,H_3PO_{4(aq)} + 6\,K_{(s)} \longrightarrow 3\,H_2\uparrow + 2\,K_3PO_{4(aq)}$$

Soln Stoichiometry!

When 26.0mL of 2.54M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

$$26.0\text{mL} \times \frac{1\text{L}}{1000\text{mL}}$$

$$2\,H_3PO_{4(aq)} + 6\,K_{(s)} \longrightarrow 3\,H_2\uparrow + 2\,K_3PO_{4(aq)}$$

Soln Stoichiometry!

When 26.0 mL of 2.54 M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

$2\,H_3PO_{4(aq)} + 6\,K_{(s)} \rightarrow 3\,H_2\uparrow + 2\,K_3PO_{4(aq)}$

$$26.0\,\cancel{mL} \times \frac{1\,L}{1000\,\cancel{mL}} \times 2.54\,M\,H_3PO_4$$

Soln Stoichiometry!

When 26.0 mL of 2.54 M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

$2\,H_3PO_{4(aq)} + 6\,K_{(s)} \rightarrow 3\,H_2\uparrow + 2\,K_3PO_{4(aq)}$

$$26.0\,\text{mL} \times \frac{1\,\text{L}}{1000\,\text{mL}} \times 2.54\,\frac{\text{mol}}{\text{L}}\,H_3PO_4$$

Soln Stoichiometry!

When 26.0 mL of 2.54 M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

$2\,H_3PO_{4(aq)} + 6\,K_{(s)} \rightarrow 3\,H_2\uparrow + 2\,K_3PO_{4(aq)}$

$$26.0\,\text{mL} \times \frac{1\,\text{L}}{1000\,\text{mL}} \times 2.54\,\frac{\text{mol}}{\text{L}}\,H_3PO_4$$

$$\text{L} \times \frac{\text{mol}}{\text{L}}$$

Soln Stoichiometry!

When 26.0 mL of 2.54 M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

$2\,H_3PO_{4(aq)} + 6\,K_{(s)} \rightarrow 3\,H_2\uparrow + 2\,K_3PO_{4(aq)}$

$$26.0\,\cancel{mL} \times \frac{1\,\cancel{L}}{1000\,\cancel{mL}} \times 2.54\,\frac{mol}{\cancel{L}}\,H_3PO_4 \times \frac{3\,mol\,H_2}{2\,mol\,H_3PO_4}$$

$$\cancel{L} \times \frac{mol}{\cancel{L}}$$

Soln Stoichiometry!

When 26.0 mL of 2.54 M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

$2\,H_3PO_{4(aq)} + 6\,K_{(s)} \rightarrow 3\,H_2\uparrow + 2\,K_3PO_{4(aq)}$

$$26.0\,\text{mL} \times \frac{1\,\text{L}}{1000\,\text{mL}} \times 2.54\,\frac{\text{mol}}{\text{L}}\,H_3PO_4 \times \frac{3\,\text{mol}\,H_2}{2\,\text{mol}\,H_3PO_4}$$

$$\text{L} \times \frac{\text{mol}}{\text{L}}$$

Soln Stoichiometry!

When 26.0 mL of 2.54 M H_3PO_4 Reacts w/ an excess of K, what volume of Hydrogen will Be Produced @ STP?

$2\,H_3PO_{4(aq)} + 6\,K_{(s)} \rightarrow 3\,H_2\uparrow + 2\,K_3PO_{4(aq)}$

$$26.0\,\text{mL} \times \frac{1\,\text{L}}{1000\,\text{mL}} \times 2.54\,\frac{\text{mol}}{\text{L}}\,H_3PO_4 \times \frac{3\,\text{mol}\,H_2}{2\,\text{mol}\,H_3PO_4} \times \frac{22.4\,\text{L}\,H_2}{1\,\text{mol}\,H_2} = 2.22\,\text{L}\,H_2$$

$$\text{L} \times \frac{\text{mol}}{\text{L}}$$

Vapor Pressure.

Vapor Pressure - Pressure Exerted by a vapor.

Vapor Pressure (VP) - Pressure Exerted by a vapor.

volatile - high VP - evaporate Readily

Vapor Pressure (VP) - Pressure Exerted by a vapor.

volatile - high VP - evaporate Readily

nonvolatile - low VP - don't evap Readily

Equilibrium VP

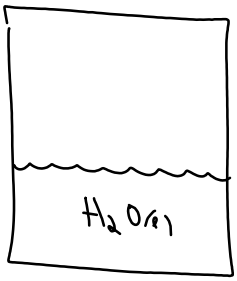
Equilibrium VP

Equilibrium VP

Dynamic condition
where 2 opposing processes
happen @ Equal Rates

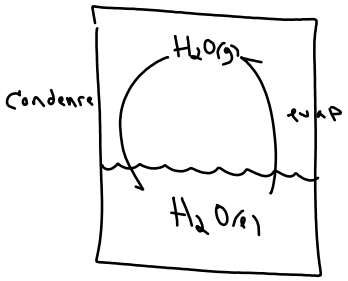
Equilibrium VP

Dynamic condition where 2 opposing processes happen @ Equal Rates



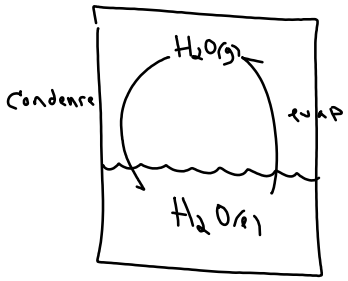
Equilibrium VP

Dynamic condition where 2 opposing processes happen @ Equal Rates



Equilibrium VP

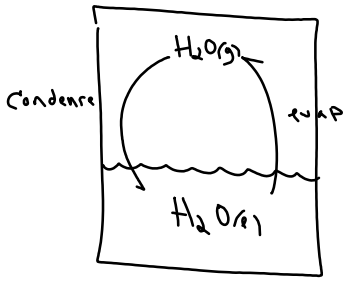
Dynamic condition where 2 opposing processes happen @ Equal Rates



$H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$

Equilibrium VP

Le Châtlier's Principle

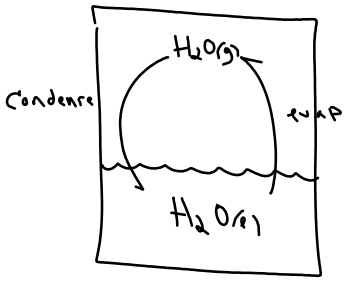


$H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$

Equilibrium VP

Le Châtlier's Principle

If an Eq is stressed, the Eq will shift to Relieve that stress



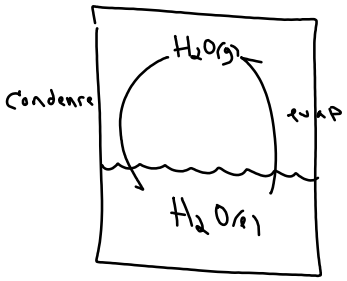
$H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$

Equilibrium VP

Le Châtlier's Principle

If an Eq is stressed, the Eq will shift to Relieve that stress

Stress: Increase/Decrease T or P
Add Remove/React or Pied



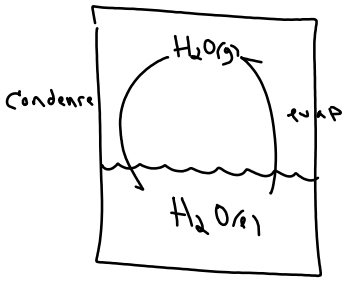
$H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$

Equilibrium VP

Le Châtlier's Principle

If an Eq is stressed, the Eq will shift to Relieve that stress

Stress: Increase/Decrease T or P
Add Remove/React or Pied



$E + H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$

Boiling Point - T in which VP of liquid equals atmospheric P

Boiling Point - T in which VP of liquid equals atmospheric P

(Normal BP is when VP equals SP)

Phase Diagram

Phase Diagram

↳ Indicate @ which T + P's all 3 phases of a substance will exist

Phase Diagram

↳ Indicate @ which T + P's all 3 phases of a substance will exist

Phase Diagram

↳ Indicate @ which T + P's all 3 phases of a substance will exist

sublimation - converting from solid to gas

Phase Diagram

↳ Indicate @ which T + P's all 3 phases of a substance will exist

sublimation - converting from solid to gas

deposition - " " gas to a solid

Phase Diagram

↳ Indicate @ which T + P's all 3 phases of a substance will exist

Critical Temp- T in which substance will be a gas No matter the P.

Phase Diagram

↳ Indicate @ which T + P's all 3 phases of a substance will exist

Critical Temp - T in which substance will be a gas No matter the P.

Triple Pt - T + P in which all 3 phases of a sub coexist

Colligative Props -

Colligative Props - props that depend on the amount of solute dissolved in solvent.

Colligative Props - props that depend on the amount of solute dissolved in solvent.

VP, BP, FP

Colligative Props - props that depend on the amount of solute dissolved in solvent.

VP, BP, FP

If solute conc ↑, VP ↓

Colligative Props - props that depend on the amount of solute dissolved in solvent.

VP, BP, FP

It solute conc ↑, VP ↓

Colligative Props - props that depend on the amount of solute dissolved in solvent.

VP, BP, FP

If solute conc ↑, VP ↓ B/c the solute attracts the solvent (and physically blocks it) making less solvent form vapor.

Colligative Props - props that depend on the amount of solute dissolved in solvent.

VP, BP, FF

If solute conc ↑, VP ↓ B/c the solute attracts the solvent (and physically blocks it) making less solvent form vapor.

↳ This cause BP ↑ (B/c VP is lower so more E is Req'd to Reach atm P)

- Solute concentration ↑, FP ↓

Solute concentration ↑, FP↓ B/c the molecules must move slower to form the solid B/c the solute particles are in the way

Boiling Pt elevation

Boiling Pt elevation

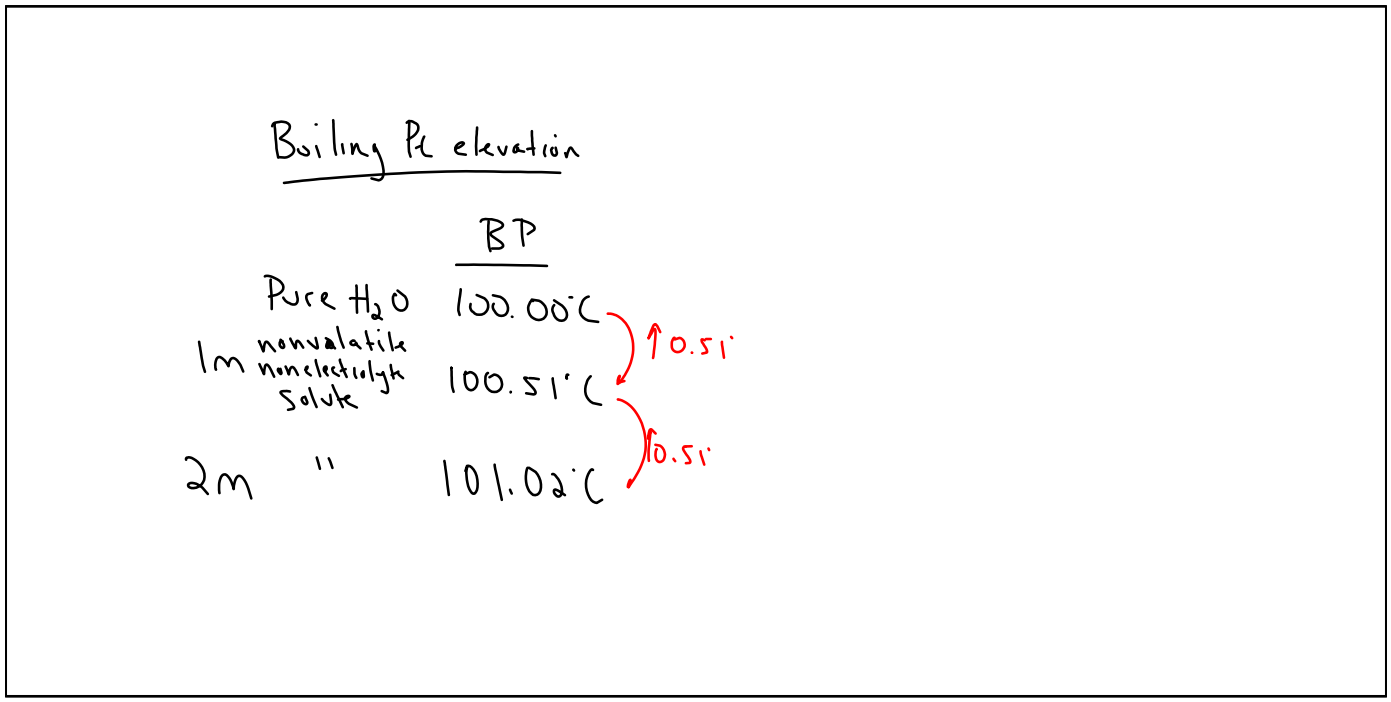
	BP
Pure H_2O	100.00°C

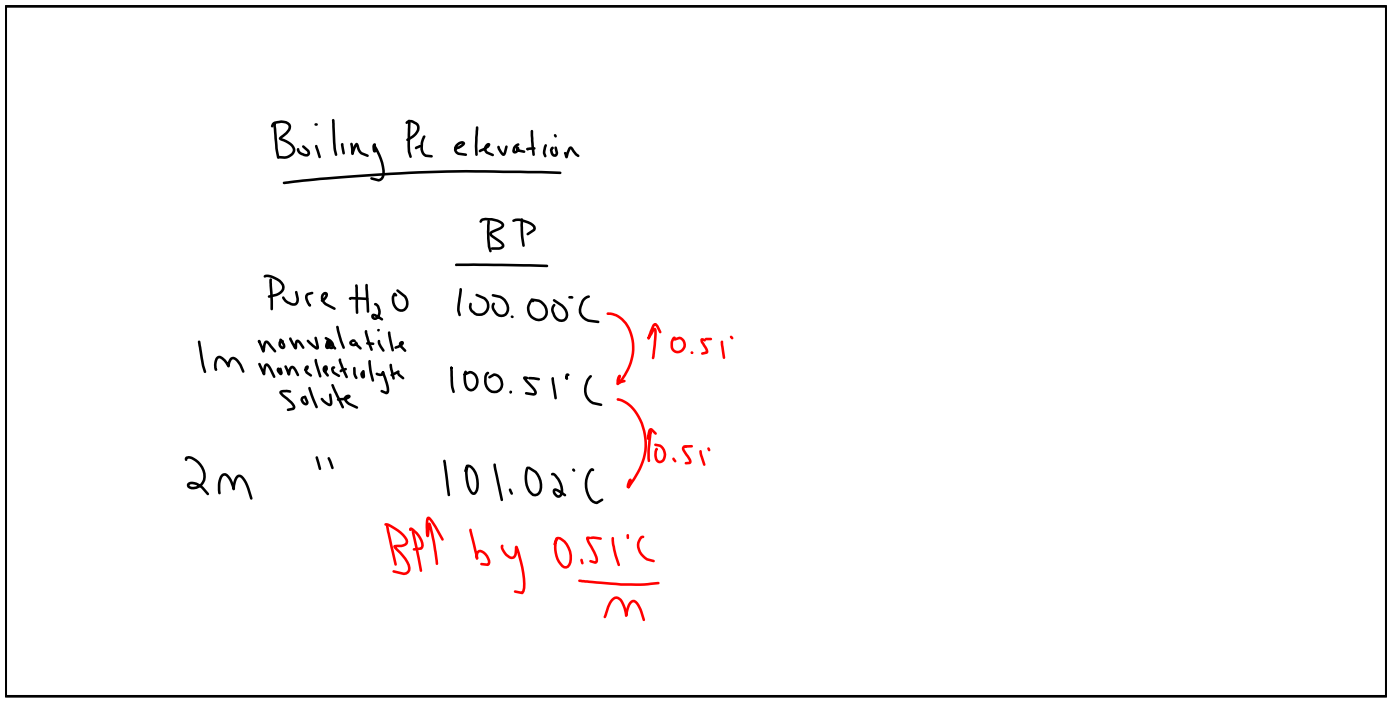
Boiling Pt elevation

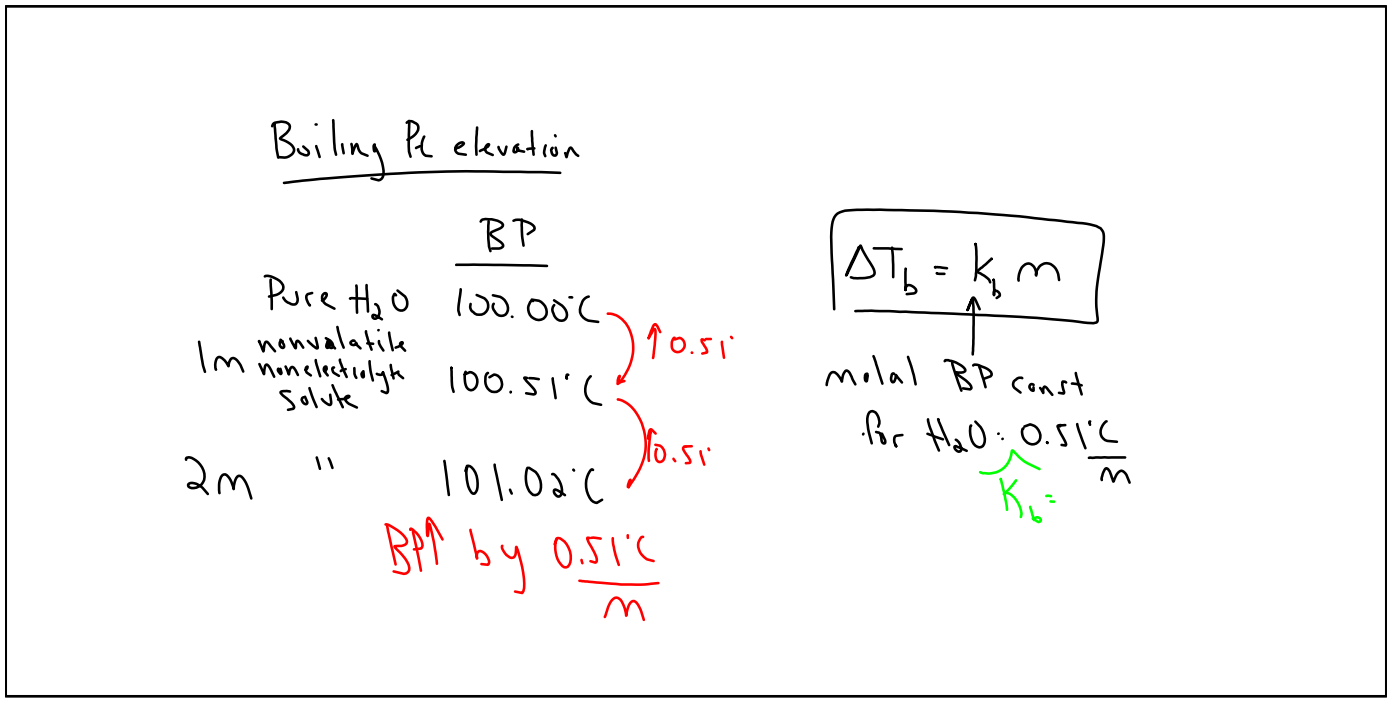
	BP
Pure H_2O	100.00°C
1m nonvolatile nonelectrolyte solute	100.51°C

Boiling Pt elevation

	BP
Pure H_2O	100.00°C
1m nonvolatile nonelectrolyte solute	100.51°C
2m "	101.02°C


Boiling Pt elevation
BP
Pure H_2O
100.00°C
1m nonvolatile nonelectrolyte solute
100.51°C
↑0.51°
2m "
101.02°C
↑0.51°


Boiling Pt elevation
BP
Pure H_2O
100.00°C
1m nonvolatile nonelectrolyte solute
100.51°C
↑0.51°
2m "
101.02°C
↑0.51°
BP↑ by 0.51°C/m


Boiling Pt elevation
BP
Pure H_2O 100.00°C
1m nonvolatile nonelectrolyte solute 100.51°C
↑0.51°
2m " 101.02°C
↑0.51°
BP↑ by 0.51°C/m
$\Delta T_b = k_b m$
molal BP const
for H_2O: 0.51°C/m
K_b =

Freezing Pt Depression

Freezing Pt Depression

	FP
Pure H_2O	0.00°C

Freezing Pt Depression

	FP
Pure H_2O	0.00°C
1 m (1 mole / 1 molal)	−1.86°C

Freezing Pt Depression

	FP
Pure H_2O	0.00°C
1m (1 mol / molal)	−1.86°C
2m "	−3.74°C

Freezing Pt Depression

	FP
Pure H_2O	0.00°C
1 m (1 mol / molecules)	−1.86°C
2 m "	−3.74°C

FP ↓ by 1.86°

Freezing Pt Depression

	FP
Pure H_2O	0.00°C
1 m (1 mol / kg)	−1.86°C (FP ↓ by 1.86°)
2 m	−3.72°C (FP ↓ by 1.86°)

Freezing Pt Depression

	FP
Pure H_2O	0.00°C
1 m (1 mol molecules)	−1.86°C (FP ↓ by 1.86°)
2 m "	−3.72°C (FP ↓ by 1.86°)

$\Delta T_f = k_f \, m$

Freezing Pt Depression

	FP
Pure H_2O	0.00°C
1 m (1 mol molecules)	−1.86°C (FP ↓ by 1.86°)
2 m "	−3.72°C (FP ↓ by 1.86°)

$\Delta T_f = k_f m$

molal FP const

for H_2O $k_f = 1.86 \frac{°C}{m}$

What are the new FP + BP's of 62.1 g of glucose dissolving in 426 g of H_2O?

What are the new FP + BP's of 62.1 g of glucose dissolving in 426 g of H_2O?

$62.1\ g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180\ g\ C_6H_{12}O_6} = 0.345\ mol\ C_6H_{12}O_6$

$426\ g\ H_2O \times \frac{1\ kg}{1000\ g} \therefore 0.426\ kg\ H_2O$

What are the new FP + BP's of 62.1 g of glucose dissolving in 426 g of H_2O?

$62.1\ g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180\ g\ C_6H_{12}O_6} = 0.345\ mol\ C_6H_{12}O_6$

$426\ g\ H_2O \times \frac{1\ kg}{1000\ g} = 0.426\ kg\ H_2O$

$\frac{0.345\ mol\ C_6H_{12}O_6}{0.426\ kg} = 0.809\ m\ C_6H_{12}O_6$

What are the new FP + BP's of 62.1 g of glucose dissolving in 426 g of H_2O?

$62.1\ g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180\ g\ C_6H_{12}O_6} = 0.345\ mol\ C_6H_{12}O_6$

$426\ g\ H_2O \times \frac{1\ kg}{1000\ g} = 0.426\ kg\ H_2O$

$\frac{0.345\ mol\ C_6H_{12}O_6}{0.426\ kg} = 0.809\ m\ C_6H_{12}O_6$

$\Delta T_f = (0.809\ m)\left(1.86\ \frac{°C}{m}\right) =$

What are the new FP + BP's of 62.1 g of glucose dissolving in 426 g of H_2O?

$62.1\ g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180\ g\ C_6H_{12}O_6} = 0.345\ mol\ C_6H_{12}O_6$

$426\ g\ H_2O \times \frac{1\ kg}{1000\ g} = 0.426\ kg\ H_2O$

$\frac{0.345\ mol\ C_6H_{12}O_6}{0.426\ kg} = 0.809\ m\ C_6H_{12}O_6$

$\Delta T_f = (0.809\ m)(1.86\ ^\circ C/m) = \boxed{-1.50\ ^\circ C}$

What are the new FP + BP's of 62.1 g of glucose dissolving in 426 g of H_2O?

$62.1\ g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180\ g\ C_6H_{12}O_6} = 0.345\ mol\ C_6H_{12}O_6$

$426\ g\ H_2O \times \frac{1\ kg}{1000\ g} = 0.426\ kg\ H_2O$

$\frac{0.345\ mol\ C_6H_{12}O_6}{0.426\ kg} = 0.809\ m\ C_6H_{12}O_6$

$\Delta T_f = (0.809\ m)(1.86\ ^\circ C/m) = \boxed{-1.50\ ^\circ C}$

$\Delta T_b = (0.809\ m)(0.51\ ^\circ C/m) = 0.413\ ^\circ C$

What are the new FP + BP's of 62.1 g of glucose dissolving in 426 g of H_2O?

$62.1\ g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180\ g\ C_6H_{12}O_6} = 0.345\ mol\ C_6H_{12}O_6$

$426\ g\ H_2O \times \frac{1\ kg}{1000\ g} = 0.426\ kg\ H_2O$

$\frac{0.345\ mol\ C_6H_{12}O_6}{0.426\ kg} = 0.809\ m\ C_6H_{12}O_6$

$\Delta T_f = (0.809\ m)(1.86\ ^\circ C/m) = \boxed{-1.50\ ^\circ C}$

$\Delta T_b = (0.809\ m)(0.51\ ^\circ C/m) = 0.413\ ^\circ C$

$100.00\ ^\circ C + 0.413 = \boxed{100.413\ ^\circ C}$

electrolytes w/ FP + BP Δ's

electrolytes w/ FP + BP Δ's

↳ dissociate in H_2O when dissolving

electrolytes w/ FP + BP Δ's

↳ dissociate in H_2O when dissolving

$NaCl_{(s)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$ (2 ions)

$CaCl_2 \longrightarrow Ca^{2+} + 2Cl^-$ (3 ions)

electrolytes w/ FP + BP Δ's

↳ dissociate in H_2O when dissolving

$NaCl_{(s)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$ (2 ions)

$CaCl_2 \longrightarrow Ca^{2+} + 2Cl^-$ (3 ions)

} ↑ # of solute particles ↑ so m ↑

electrolytes w/ FP + BP Δ's — 1 m NaCl

↳ dissociate in H_2O when dissolving — 1 m $CaCl_2$

$NaCl_{(s)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$ (2 ions)

$CaCl_2 \rightarrow Ca^{2+} + 2Cl^-$ (3 ions)

} ↑ # of solute particles, so m ↑

electrolytes w/ FP + BP Δ's

↳ dissociate in H_2O when dissolving

1 m NaCl ⟶ 2 m ions

1 m $CaCl_2$ ⟶ 3 m ions

$NaCl_{(s)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$ (2 ions)

$CaCl_2 \longrightarrow Ca^{2+} + 2Cl^-$ (3 ions)

} ↑ # of solute particles ↑ so m ↑

electrolytes w/ FP + BP Δ's

↳ dissociate in H_2O when dissolving

1 m NaCl ⟶ 2 m ions

1 m $CaCl_2$ ⟶ 3 m ions

$\Delta T_b = k_b m$ $\Delta T_f = k_f m$

electrolytes w/ FP + BP Δ's

↳ dissociate in H_2O when dissolving

1 m NaCl ⟶ 2 m ions

1 m $CaCl_2$ ⟶ 3 m ions

$\Delta T_b = i K_b m$ $\Delta T_f = i K_f m$

electrolytes w/ FP + BP Δ's

↳ dissociate in H_2O when dissolving

1 m NaCl ⟶ 2 m ions

1 m $CaCl_2$ ⟶ 3 m ions

$\Delta T_b = i K_b m$ $\Delta T_f = i K_f m$

i = Van't Hoff factor - takes into account ion dissociations

electrolytes w/ FP + BP Δ's

↳ dissociate in H_2O when dissolving

1 m NaCl ⟶ 2 m ions

1 m $CaCl_2$ ⟶ 3 m ions

$\Delta T_b = i K_b m$ $\Delta T_f = i K_f m$

i = Van't Hoff factor - takes into account ion dissociations

NaCl $\frac{i}{2}$

$CaCl_2$ 3